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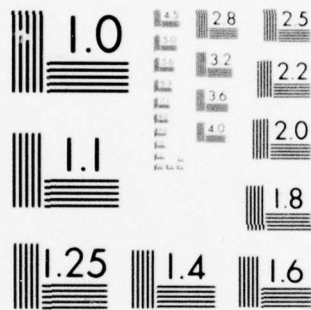
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Report Number 3

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MEDICAL ENTOMOLOGY PROJECT

ANNUAL REPORT

Oliver S. Flint, Jr.

September 1, 1977

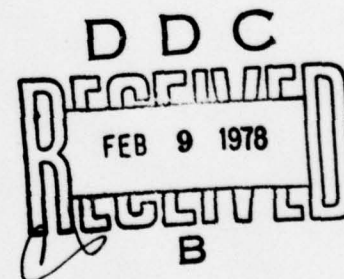
For the period July 1, 1976 to June 30, 1977

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The Medical Entomology Project (MEP), a cooperative venture between the Smithsonian Institution and the U. S. Army Medical Research and Development Command, conducts biosystematic research on arthropods of medical importance to the Army. MEP fulfills this requirement by performing biosystematic studies on important groups of vectors such as anopheline vectors of malaria and culicine vectors of arbovirus diseases, providing information on potential vectors for the guidance of military field			

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research teams and other governmental agencies and preparing monographs and technical papers which summarize data on the ecology, taxonomy and medical importance of arthropod vectors in various regions of the world. In addition, MEP performs curation and research on the national collection of mosquitoes at the National Museum of Natural History, (USNM), Smithsonian Institution. *The report reviews progress in → (cont on p. iv)*

Three monographs were published during the year as follows: subgenus Culex of the Oriental region, subgenus Stegomyia of the genus Aedes (edwardsi and w-albus groups of species) with notes on the status of Aedes vittatus and subgenus Rhinoskusea of genus Aedes. These monographs contained 464 pages, including 136 full-page illustrations. At the conclusion of the contract year, camera-ready copy of the following additional monographs had been prepared: subgenus Lophoceraomyia of genus Culex of the Oriental region, subgenus Christophersiomyia of genus Aedes and subgenus Pseudoficalbia of genus Uranotaenia of Southeast Asia. When published, these revisions will contain 590 pages, including 170 full-page illustrations.

Early drafts and illustrations were prepared for the following monographs: tarsimaculatus group of the subgenus Nyssorhynchus of genus Anopheles (New World), Aedes scutellaris group of Tonga and keys to the species and characterization of subgenus Stegomyia of the genus Aedes of the Oriental region. Research is continuing on malaria vector groups including Anopheles leucosphyrus group of the Oriental region, New World argyritarsis group of the subgenus Nyssorhynchus and the New World arribalzagia group of the subgenus Anopheles. With the completion of studies on Oriental Culex species, work commenced on the subgenus Melanoconion of genus Culex which contains many important arbovirus vectors in Central and South America.

To implement the above biosystematic investigations, field studies were conducted in Panama, Colombia and Ecuador.

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SUMMARY

The Medical Entomology Project (MEP), a cooperative venture between the Smithsonian Institution and the U.S. Army Medical Research and Development Command, conducts biosystematic research on arthropods of medical importance to the Army. MEP fulfills this requirement by performing biosystematic studies on important groups of vectors such as anopheline vectors of malaria and culicine vectors of arbovirus diseases, providing information on potential vectors for the guidance of military field research teams and other governmental agencies and preparing monographs and technical papers which summarize data on the ecology, taxonomy and medical importance of arthropod vectors in various regions of the world. In addition, MEP performs curation and research on the national collection of mosquitoes at the National Museum of Natural History (USNM), Smithsonian Institution.

Three monographs were published during the year as follows: subgenus Culex of the Oriental region, subgenus Stegomyia of genus Aedes (edwardsi and w-albus groups of species) with notes on the status of Aedes vittatus and subgenus Rhinoskusea of genus Aedes. These monographs contained 464 pages, including 136 full-page illustrations. At the conclusion of the contract year, camera-ready copy of the following additional monographs had been prepared: subgenus Lophoceraomyia of genus Culex of the Oriental region, subgenus Christophersiomyia of genus Aedes and subgenus Pseudoficalbia of genus Uranotaenia of Southeast Asia. When published, these revisions will contain 590 pages, including 170 full-page illustrations.

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To implement the above biosystematic investigations, field studies were conducted in Panama, Colombia and Ecuador.

INTRODUCTION

Biosystematic studies which lead to the precise identification of vectors are fundamental to any investigation of epidemiology and to the planning of control or eradication. They enable the vector or vectors to be recognized; their ecology and habits to be studied and information about vectorial capacity, resistance to insecticides, geographic distribution and so on to be passed on to other workers. Many instances of failure to control diseases resulting from vector borne pathogens can be traced to neglect of this aspect of preventive medicine research.

The Medical Entomology Project (MEP) was developed to perform biosystematic research on medically important arthropods to meet the U.S. Army Medical Research and Development Command's requirements for accurate identification of actual or potential vectors of human pathogens throughout the world. Thus, MEP is able to respond to these needs and the resources of the project are used to accomplish these requirements. This research was accomplished by a staff of 21, which included 7 medical entomologists and the principal investigator (Appendix 1).

In addition, upon request, MEP provides synoptic collections of specimens for the use of various military entomologists and assists them in biosystematic studies of medically important arthropods. This level of support may range from furnishing entomologists with keys, and other identification guides to the loan of specialized collecting and rearing equipment which cannot be obtained from other sources. Such support has proven invaluable to all concerned, as the Smithsonian Institution has received extremely worthwhile material from these entomologists.

REVIEW OF PROGRESS FOR THE PERIOD
1 JULY 1976 TO 30 JUNE 1977

1. Biosystematic Studies on Culicidae

a. Genus Anopheles

(1) Subgenus Cellia (leucosphyrus group) of the Oriental region
(E. L. Peyton)

During the year, many specimens were borrowed from several institutions in order to examine material referred to in earlier publications and to obtain species not well represented in the MEP collections. All life stages are available for every species except for the immature stages of the "Celebes form" of sulawesi Waktoedi. Attempts are being made to obtain these through various contacts in Indonesia.

Good progress has been made on the study to date. A preliminary examination and sorting of all available material has been accomplished. In addition, 675 slides and approximately 1,000 adults of unidentified Anopheles in the MEP collection were examined in search of additional specimens of the group. Specific problems to be resolved have been tentatively identified and efforts during the coming year will focus on these problems. This will require a complete analysis of samples of all stages representing various geographic populations of several recognized forms or variants of balabacensis balabacensis Baisas. It will involve the considerable task of the counting of all setal branching of large samples of larvae and pupae and of all the many wing and leg spots and other combinations of adult characters. In view of the considerable degree of variation noted in earlier studies on the group, it is planned to analyze in detail a larger sample for each species than is usually done.

Examination of material thus far has revealed the following. All of the species and subspecies recognized by Colless and Reid are valid. However, present evidence suggests that balabacensis introlatus Colless might be elevated to full specific status. A rather lengthy discussion of problems in southern Thailand was included in the last MEP report of 11 January 1977. Material from this area was critically examined and the problems in this region are not as complex as originally reported by Reid and others. Failure to recognize the presence of a sixth species, leucosphyrus Dönitz, has been the main source of identification problems in this area. Specimens of this species, newly discovered from Thailand, have been treated earlier as hybrids or inter-

mediates between b. balabacensis and b. introlatus and this led Reid and others to treat introlatus as a subspecies. Based on material examined, there is no evidence to support the theory of a zone of intergradation between these 2 forms in southern Thailand. Therefore, introlatus will probably be accorded specific rank. The inclusion of leucosphyrus in the southern Thailand fauna increases the known number of species to 6 and now includes all of the species previously recognized from Peninsular Malaysia. This zone then contains approximately 40% of the known species of the group and a greater representation than any other area in the Oriental region. Three slightly different populations of balabacensis have been noted in Thailand material. Specimens from the southeastern province of Chanthaburi and the southern province of Nakhon Si Thammarat show some differences in adult morphology from those of the rest of the country, northern Malaya, Assam and Bangladesh. Whether these represent distinct taxa or normal variations of a single species is yet to be determined. The typical balabacensis of Thailand and other areas north of Malaya also differ slightly from balabacensis sensu strictu, but more detailed studies are required before a final decision is made on the status of these populations.

(2) Subgenus Anopheles of the Neotropical region (G. K. Bryce)

Further research on the arribalzaga group of the subgenus Anopheles was conducted during the year. Emphasis has been placed upon an examination of prepared slides of whole larvae present in the Mosquitoes of Middle America collection. This material consisted of apicimacula Dyar and Knab (mostly from Panama), mediopunctatus (Theobald) (Trinidad), minor Da Costa Lima (Brazil), neomaculipalpus Curry (Panama) and punctimacula complex (mostly from Panama). During this period, male genitalia of the following species have been examined: apicimacula, gabaldoni Vargas, intermedius (Peryassu), neomaculipalpus and the punctimacula complex. For both male genitalia and whole larvae, additional material must be studied before any interpretations are attempted. The early portion of the summer of 1977 will be spent preparing available material for examination. It is planned to complete the revision of this group in the latter part of 1978.

(3) Subgenus Nyssorhynchus, argyritarsis section (K. L. Linthicum)

The revision of the argyritarsis section of the subgenus Nyssorhynchus of Anopheles is in the final stages of completion. At present, 8 species are recognized as follows: albitarsis Lynch Arribalzaga, allopha Peryassu, braziliensis Chagas, argyritarsis Robineau-Desvoidy, sawyeri Causey, Deane, Deane and Sampaio,

lanei Galvão and Amaral, darlingi Root and pictipennis Philippi. All material present in the Mosquitoes of Middle America collection as well as all relevant specimens in the USNM have been examined. A review of the literature for the argyritarsis section has been completed. Rough drafts of keys to adult females, male genitalia, larvae and pupae have been completed. In addition, rough drafts of descriptions of female and male adults, male and female genitalia, pupae and larvae have also been completed. Sections of the monograph on systematic discussions, bionomics and medical importance are being completed. It is expected that a completed draft will be available by the end of September 1977.

(4) Subgenus Nyssorhynchus, albimanus section (M. E. Faran)

The major portion of a revision of the albimanus section of the subgenus Nyssorhynchus of Anopheles was largely completed. This revision is based on a study of 8,929 specimens: 2,114 males, 2,668 females, 1,666 pupae and 2,481 larvae, including 1,262 individual rearings (611 larval, 526 pupal, 125 incomplete). Individually reared specimens were available for 10 of the 13 species considered. For 2 of the more medically important species, albimanus Wiedemann and aquasalis Curry, abundant individually-reared material from almost their entire geographic range was available permitting the analysis of intra- and interpopulational variation(s) within these species.

The albimanus section of the subgenus Nyssorhynchus is characterized in the adults by the basal dark band on hindtarsal segment 5 and in the male genitalia by the variously developed fused ventral claspette. The albimanus section is most closely allied to the argyritarsis section with which it shares several features. The subgenus Nyssorhynchus retains several ancestral characters and is clearly differentiated from other subgenera of Anopheles. The entire subgenus is restricted to the Neotropics except for albimanus which extends into the Nearctic. In the present revision 13 species are recognized in the albimanus section. The nominal species sanctielii Senevet and Abonnec and galvaei Causey, Deane and Deane are not included because of the lack of material of sanctielii and because of the few damaged specimens available for galvaei.

An attempt has been made to assemble the species into distinct monophyletic groups on the basis of correlated characters in the adults and immatures. The character state, ancestral or derived, of the taxonomically important features has been determined whenever possible and evolutionary trends stated in formulating the phylogenetic relationships within the section. The section is divided into 2 groups,

the monotypic albimanus group and the oswaldoi group. Anopheles albimanus is the least derived species in the section, possessing several ancestral features which it shares with the ancestral species in the argyritarsis section. Anopheles albimanus is easily differentiated from the oswaldoi group by several correlated unique features in the adult, male genitalia and larva.

The larvae and pupae of the albimanus section occur primarily in ground water habitats. All the species breed in fresh water, except for aquasalis and often albimanus which are found in brackish water breeding sites. The females feed predominantly on large mammals. The adults are active either crepuscularly or nocturnally; however, triannulatus (Neiva and Pinto) has been reported to bite during the day.

Two species, albimanus and aquasalis, are major vectors of malaria in Central and South America and in the islands of the Caribbean. Anopheles nuneztovari Gabaldon is the primary vector of malaria in western Venezuela and northern Colombia. Anopheles triannulatus, strodei Root and noroestensis Galvão and Lane have been implicated in the transmission of malaria, since they have been found naturally infected. Anopheles rangeli Gabaldon, Cova-Garcia and Lopez has been suspected of transmitting malaria in Ecuador. Two viruses, Venezuelan equine encephalitis and Tlacotalpan virus, have been isolated from aquasalis and albimanus respectively. Nothing is known about the medical importance of the remaining species.

b. Genus Culex (S. Sirivanakarn)

(1) Subgenus Melanoconion

During the year, a preliminary study of the New World Culex subgenus Melanoconion was initiated. This phase of the work included a review and documentation of literature and the examination of the various types and identified specimens of over 80 species in the USNM collection. Through the assistance of Dr. Ronald A. Ward, loans of additional material from other institutions have been obtained. These include: (1) a large collection of about 40 species from Panama, Colombia and other adjacent countries made by Dr. Lloyd Rozeboom from the Johns Hopkins University School of Public Health, (2) type-specimens of 4 species from French Guiana collected by Dr. J. Clastrier at the Museum National d'Histoire Naturelle, Paris, and (3) specimens of about 10 species collected in Surinam by Dr. Roy S. Panday, Biology Division, Medisch Wetenschappelijk Instituut, Paramaribo, Surinam.

From a comparative study of several species representing all the subgenera of New World Culex an understanding of the taxonomic characters of the various groups has been obtained. As a result of this study, a preliminary key was prepared for sorting out members of the subgenus Melanoconion from the abundant unidentified Culex material in the USNM and other collections. In developing a comprehensive plan of study for the subgenus, some modifications of the scheme of internal classification previously developed by Rozeboom and Komp (1950) and recently modified by S. Heinemann at the University of California, Los Angeles (UCLA) (unpublished) have been made.

In order to restrict the study to certain species groups of medical importance and to determine the most important taxonomic problems needed to be resolved, consultations were held with Dr. John N. Belkin (UCLA) and Dr. Pedro Galindo (Gorgas Memorial Laboratory, Panama). From these meetings a proposal was made to concentrate working on the species in the aikenii (or ocossa) and taeniopus groups. Currently, work on the members of these 2 groups is underway. This includes curation of available material, preparation of preliminary keys to all stages for separating 10-12 presumably valid species in the above groups from 15 other common and widespread species of Melanoconion, and the examination of the type-specimens at the USNM. Other progress which has been made includes the identification of over 1,000 specimens of Melanoconion collected by E. L. Peyton for the project in Panama and Colombia during January and February 1977 and identification of 100 specimens of Culex (including mainly Melanoconion) collected from Ecuador by the Center for Disease Control, U.S. Public Health Service, Ft. Collins, Colorado. The Peyton collection contains numerous reared specimens of species in the aikenii group, all of which are vital to the solution of species problems involved in this group.

To obtain field experience and additional material for this study, a trip to Guatemala under the auspices of the Cornell University School of Medicine has been planned for the late summer of 1977.

(2) Completion of study of Oriental Culex

In completing Southeast Asian studies of Culex, 2 major revisions (subgenera Culex and Lophoceraomyia) which have been carried over from previous years were prepared for final publication during the year. Other publications included 3 taxonomic papers with descriptions of new species and additional descriptions of some poorly known species of the subgenera Eumelanomyia and Culiciomyia.

c. Genus Aedes (Y.-M. Huang)

(1) Subgenus Stegomyia of the Oriental region

The revision of the edwardsi and w-albus species groups of the subgenus Stegomyia was completed in October 1976 after being critically reviewed by 4 external specialists. No major changes in the context of the original draft were made. It was published during April 1977. A manuscript on the taxonomic status of Aedes vittatus (Bigot) was also published during April 1977.

The manuscript on the biosystematic studies of the subgenus Stegomyia of Aedes in the Oriental region was completed in March 1977. In this paper, the Oriental Stegomyia is characterized and 5 species groups are recognized and defined. Keys to the identification of species groups, subgroups and species in the Oriental region are provided. Included also are a discussion of systematics and data on distribution, biology and medical importance. It is anticipated that the manuscript with illustrations will be ready for publication in 1978.

• (2) Mosquitoes of the South Pacific

The manuscript and illustrations on "The mosquitoes of Polynesia with a pictorial key to some species associated with filariasis and/or dengue fever" was issued by the World Health Organization (WHO) during March 1977. At present, 43 species and forms belonging to 7 genera (Aedeomyia, Aedes, Culex, Mansonia, Tripteroides, Toxorhynchites and Uranotaenia) with 12 subgenera, are known to occur in the area. Keys to genera, subgenera and species in Polynesia for adults and larvae are given. In order to assist field workers in recognizing vector mosquitoes of filariasis and dengue in Polynesia, pictorial keys were prepared for the adult and larval stages of the 19 known or suspect vector species which were mentioned in the previous report. The non-pictorial keys will obviate misidentification and encourage interested workers to detect species not known to occur in these island groups, and to seek advice upon the possible discovery of new species. The keys will also assist in confirming the natural vectors of filariasis and/or dengue in the various island groups and the possible incrimination of species that are not known to be vectors at the present time. In response to the public request, this manuscript has been modified and submitted to "Mosquito Systematics" for formal publication in late 1977.

The taxonomic study of the Aedes scutellaris group of Tonga was completed in October 1976. A draft manuscript with illustrations has also been completed and sent to the reviewers. In this paper, the Aedes scutellaris group of Tonga is characterized. It contains 3 species

and one subspecies of the scutellaris group, of which one species is described as new, 2 species (cooki Belkin and tongae Edwards) revalidated, and one species (tabu Ramalingam and Belkin) is reduced to subspecies status. All the known stages of the 4 species and subspecies of the scutellaris group of Tonga are described or redescribed and illustrated. These 4 species are recorded for the first time from certain islands. Keys to the identification of the species of the scutellaris group in the Fiji-Tonga-Samoa area are provided and their geographical ranges are presented on a map.

During the course of this work more than 9,000 specimens (including 1,866 individual rearings with associated pupal and/or larval skins) of 3 species and one subspecies were examined. Special effort has been made to analyze and evaluate the characters of such highly variable species as cooki, tongae and closely related species.

d. Genus Uranotaenia (E. L. Peyton)

A completed manuscript on the subgenus Pseudoficalbia was critically reviewed by 3 external specialists during the first half of the year. Final typing, review and editing of the camera-ready copy was completed during March 1977. The manuscript will be published during August 1977 and will consist of 273 pages.

2. Field Studies in the Neotropical Region

a. Panama and Colombia

During the current year, it was planned to send Mr. E. L. Peyton to Belem, Brazil for the purpose of training personnel at the U.S. Army Medical Research Unit (Trans-Amazon) in techniques for the collection, preservation and identification of medically important mosquitoes. Due to circumstances beyond the control of the Smithsonian Institution and the contracting agency, this trip had to be cancelled for the foreseeable future.

In order to utilize available funds in support of current research, approval was received from the USAMRC for Mr. Peyton to participate in a 49 day field trip to Panama and Colombia during the period January 6 - March 3, 1977. The purpose of the trip was to collect selected species of Anopheles (Nyssorhynchus) and Culex (Melanoconion) (especially species of the Culex aikenii complex) from critical localities. With the cooperation of Drs. Pedro Galindo and Abdiel Adames of the Gorgas

Memorial Laboratory, 3 weeks were spent on field studies in Panama. The remaining time was devoted to collecting in the upper Magdalena Valley of Colombia under the auspices of Dr. Hernando Groot and associated entomologists of the Instituto Nacional de Salud, Bogota.

Approximately 1,700 pinned adults, most of them reared with associated skins, were obtained. Numerous collections of the Culex aikenii complex were encountered in both countries. Specimens of 11 species of Culex (Melanoconion) were collected. The Anopheles have not yet been studied.

b. Ecuador

Dr. Y.-M. Huang was invited by Dr. Paul J. Spangler, Associate Curator, Department of Entomology, National Museum of Natural History, Washington, D. C. and Principal Investigator of a Smithsonian project entitled "An Aquatic Insect Survey of Ecuador", to participate in field studies in Ecuador from April 30 to June 18, 1977. The main purpose of this trip was to collect and rear mosquitoes, particularly topotypic and other critical material of Culex (Melanoconion) and Anopheles (Nyssorhynchus). All field expenses were borne by Dr. Spangler's project with the exception of air fare and miscellaneous expenses.

In Ecuador, 3 collecting sites, Puyo, Tena and Limoncocha, were chosen for the field stations. These areas are all in the tropical rainforest of the upper Amazon basin. Since most species of Culex (Melanoconion) and Anopheles (Nyssorhynchus) are mainly temporary, semipermanent and permanent ground pool breeders, the collections were highly concentrated on these types of breeding habitats. Locality and ecological data have been recorded on standard collection forms and are on file with the MEP collection. A special effort was made to collect immatures, particularly the larval stage, in the natural habitat and to carry out individual rearings for obtaining adults with associated larval and pupal skins which are essential in clarifying the true identity of the species as well as in resolving species complexes. A total of 2,011 adults and 2,156 vials of associated pupal and/or larval skins and whole 4th instar larvae were obtained. All the adults have been identified and sorted out to subgenus as follows:

1.	<u>Anopheles</u> (<u>Nyssorhynchus</u>)	207 adults
	" (<u>Anopheles</u>)	5
2.	<u>Wyeomyia</u> (<u>Wyeomyia</u>)	114
3.	<u>Psorophora</u> (<u>Psorophora</u>)	68
4.	<u>Aedeomyia</u> (<u>Aedeomyia</u>)	14
5.	<u>Uranotaenia</u> (<u>Uranotaenia</u>)	13
6.	<u>Aedes</u> (<u>Ochlerotatus</u>)	20
7.	<u>Culex</u> (<u>Melanoconion</u>)	1,259
	" (<u>Culex</u>)	302
	" (<u>Carrollia</u>)	8
	" (<u>Lutzia</u>)	1

7 genera, 11 subgenera Total 2,011 adults

At least 75% of the total collected material are Culex (Melanoconion) and Anopheles (Nyssorhynchus), and a good series of all stages (male, female, larva and pupa) were obtained for each species of Culex (Melanoconion) and Anopheles (Nyssorhynchus) collected. This material will be extremely valuable for current studies at MEP.

3. Curatorial Activities

a. Status of world collection of Culicidae

For the past 25 years, the Vector Biology and Control Division of the Bureau of Tropical Diseases at the Center for Disease Control (CDC) in Atlanta, GA has maintained a research collection of medically important arthropods. Due to a change in mission during 1976 it was not possible for the CDC to maintain this collection. Arrangements were made for the transfer of the entire collection (with the exception of material kept for teaching purposes) to the Smithsonian Institution. The collection arrived in Washington early in 1977 and at present, the Culicidae (approximately 60 slide boxes and 50 Cornell drawers of specimens) are being incorporated into the world collection. This collection is of special interest as it contains numerous voucher specimens of species discussed by U.S. Public Health Service entomologists and epidemiologists in the literature on mosquito control and tropical medicine.

Since 1974, MEP has been responsible for the curation of the world collection. The collections manager, Mr. T. V. Gaffigan, has added new material to the collection and rearranged existing specimens as time permitted.

b. Accessions and other activities of the MEP collections management section

The 58 accessions received by MEP are summarized in Appendix 2. During 1976-77, these totaled almost 20,000 specimens. Two important accessions were the result of field collections by MEP staff members. Of these, 3,159 specimens were collected in Panama and Columbia and 4,167 specimens were collected in Ecuador. Other significant accessions were received from SEATO Medical Research Laboratory (2,742 specimens - Thailand) and R.M. Rosenberg, Johns Hopkins University (2,975 specimens - Bangladesh). Outgoing material for this period (loans, return of borrowed specimens and type depositions) totaled 12,032 specimens (6,690 adults, 5,275 slides and 67 unmounted immatures). The largest loan processed was a shipment of Oriental and Papuan Toxorhynchites to Dr. W.A. Steffan who is currently conducting revisionary studies in the genus.

4. Other Activities

a. Identification services

During the year, the project received approximately 20 lots of specimens for identification. Approximately one-third of these were routine identifications for the U.S. Department of Agriculture while the balance were from Department of Defense and other agencies. Some of the groups which submitted specimens were as follows: Armed Forces Institute of Pathology, Washington, D.C. - Dermatobia and Simulium; University of Maryland International Center for Medical Research and Training, Lahore - Culex spp.; U.S. Embassy Nepal - Ixodid ticks; U.S. Army Medical Laboratory, Germany - Sarcophagidae; 1st Medical Service Wing, U.S. Air Force, Philippines - Aedes and Culex spp.; Naval Regional Medical Center, Guam - Aedes spp.; Dr. R.S. Panday, Surinam - Anopheles nuneztovari; U.S. Army Medical Research Unit, Brazil - 4 boxes Tabanidae; Service Nacional Erradicacion de Malaria, Ecuador - Aedes aegypti (L.); U.S. Public Health Service, Ft. Collins, Colorado - Culex (Melanoconion) spp.; School of Aerospace Medicine, U.S. Air Force, Texas - Cochliomyia macellaria; Dr. Donald Pletsch - Galapagos islands mosquitoes; and Health and Environmental Activity, U.S. Army, Ft. Knox, Kentucky - Aedes tormentor Dyar and Knab.

b. Publications

Fourteen papers were published under the auspices of the project during the year (Appendix 3). These included 3 revisions of monographic

scope in the "Medical entomology studies" series (Huang 1977; Reinert 1976b and Sirivanakarn 1976) while the other papers were published in journals or books other than the "Contributions of the American Entomological Institute." Two of the publications (Harbach and Knight 1977a, 1977b), represent a continuation of the mosquito taxonomic glossary originally authored by Drs. K.L. Knight and J.L. Laffoon.

Final drafts of the following monographs were accepted for publication during the coming year: subgenus Christophersiomyia of genus Aedes - CPT J. Abercrombie; subgenus Pseudoficalbia of genus Uranotaenia of Southeast Asia - Mr. E.L. Peyton; subgenus Lophoceraomyia of genus Culex of Oriental region - Dr. S. Sirivanakarn.

A 1,005 page manuscript with 262 accompanying plates was received from Dr. Kazuo Tanaka, formerly of the U.S. Army Medical Laboratory (Pacific). This monograph on the mosquitoes of Japan, Korea and the Ryukyu islands will be reviewed, edited and published by MEP due to the closure of the above Army laboratory. As many of the illustrations require labeling and modification, it is expected that approximately 18 months will be needed to prepare this publication.

c. Illustrations

The scientific illustration staff maintained a high level of productivity during the year and more than 300 inked drawings were completed. An additional 80 illustrations were drawn in pencil, prior to approval for final inking. Corrections or modifications were made to more than 200 previously completed plates. The modifications accomplished included the complete labeling of chaetotaxy on 70 plates of larval illustrations prepared by illustrators at the former U.S. Army Laboratory (Pacific) for the Tanaka et al. monograph on Japanese and Korean mosquitoes.

With the publication of several large monographs, the illustrators were able to devote more time for the preparation of plates for collaborators. These included the following plates: Anopheles minimus group - 17; Tripteroides - 10; Armigeres - 6; Anopheles gambiae group - 1; Toxorhynchites (Ethiopian species) - 6; Culex (Maillotia) - 1; and larval mouthparts (for mosquito glossary) - 12.

Mr. Vichai Malikul participated in the teaching program of the summer workshop in Natural Science Illustration in the U.S. Department of Agriculture Graduate School on June 28, 1976. At the 15th International Congress of Entomology he presented a demonstration of the work technique as applied to the rendering of mosquito habitus illustrations.

d. Scientific literature

The remaining material from the U.S. Department of Agriculture mosquito literature file was incorporated into the MEP collection. As in previous years several hundred duplicate reprints were sent to the Military Entomology Information Service, Armed Forces Pest Control Board for inclusion in their files.

A final draft of the revised mosquito catalog was received from Dr. Knight and approximately 98% of the 3,000+ literature citations were checked against the original publications by Dr. Ward. Large portions of the systematic portion of the catalog were reviewed by the MEP staff taxonomists.

In addition to internal usage of the literature files, large numbers of references were furnished to Dr. W.A. Steffan for a planned revision of the genus Toxorhynchites and Dr. B. de Meillon for a review of recent literature on Bancroftian filariasis.

e. Participation in scientific activities

Dr. O.S. Flint, Jr., served as the Smithsonian Institution liaison representative to the Armed Forces Pest Control Board and presented 3 reports concerning MEP activities at the quarterly meetings of the Board.

Dr. R.A. Ward organized a plenary symposium at the 15th International Congress of Entomology, Washington, D.C. entitled, "Changing patterns in the transmission of arthropod borne diseases." Papers presented at this symposium on August 26, 1976 were published in the proceedings of the Congress. The entire professional staff of MEP were registered members of the Congress. Scientific illustrations were displayed at the Congress in a special exhibit by Mrs. T.F. Smith, Mr. V. Malikul, Mrs. A.H. Dery, Mr. Y.T. Sohn and Mrs. C.C. Chang.

On October 28, 1976, Drs. Flint and Ward and Mr. E.L. Peyton were invited to attend the annual meeting of the Gorgas Memorial Institute which was held at the Pan American Health Organization building in Washington, D.C. While there, they held discussions with Dr. Pedro Galindo concerning future collaborative studies in Panama.

In May 1977, Mr. Peyton and Dr. Sirivanakarn participated (at no expense to MEP) in the Biosystematics Research Symposium sponsored by the Agricultural Research Service in Beltsville, Maryland.

Dr. Ward travelled to Raleigh, North Carolina on February 7-8, 1977 (at no expense to MEP) where he presented a seminar to the Department of Entomology, North Carolina State University and discussed various research studies with staff members. On May 24, 1977, Dr. Ward was invited to the Johns Hopkins University School of Public Health, Baltimore, Maryland to present a seminar on the "Ecology of African sleeping sickness."

f. Visitors

As in the previous year, approximately 40 entomologists and other scientists visited the project. The greatest number of individuals (18) visited MEP during August 1976 in conjunction with attending the 15th International Congress of Entomology. Overseas visitors included: Dr. S. Asahina (National Institute of Health, Tokyo). Dr. M. Aslamkhan (Pakistan Medical Research Center, Lahore), Dr. H.R. Bhat (Virus Center, Poona, India), Dr. J.J.S. Burton (University of California International Center for Medical Research, Kuala Lumpur, Malaysia), Mr. W.H. Cheong (Institute for Medical Research, Kuala Lumpur), Dr. B.N. Chowdaiah (Bangalore University, India), Dr. J. Clastrier (Museum National d'Histoire Naturelle, Paris), Dr. Roger Crosskey (British Museum (Natural History), London), Dr. Pedro Galindo (Gorgas Memorial Laboratory, Panama), Dr. Douglas J. Gould (SEATO Medical Research Laboratory, Bangkok), Dr. Jacques Hamon (World Health Organization, Geneva), Dr. Richard Lane (British Museum (Natural History), London), Dr. Ellicott McConnell (NAMRU-5, Addis Ababa, Ethiopia), Dr. Elizabeth N. Marks (Queensland Institute of Medical Research, Brisbane), Dr. Simon Miles (Ross Institute of Tropical Hygiene, London), Dr. Jean Mouchet (ORSTOM, Bondy, France), Dr. H.E. Paterson (University of Witwatersrand, South Africa) and Dr. D.M. Wood (Biosystematics Research Institute, Ottawa).

Dr. W.A. Steffan (Bishop Museum, Honolulu) spent several days in August 1976 at the project examining specimens of the genus Toxorhynchites and reviewing literature in preparation for studies on the genus.

Dr. D.M. Wood completed the study of certain North American mosquitoes during October 1976 for his manual on the Canadian Culicidae.

g. Consultants

The consultants of MEP are indicated in Appendix 4. Work on the genera Tripterooides and Armigeres is being continued by Drs. Mattingly and Ramalingam respectively. Major Harrison has completed the basic systematic analysis of the Anopheles minimus species group and is presently preparing a manuscript for publication. Dr. White has

begun his revision of the African culicid identification manuals and has sent specimens for illustration. Dr. Galindo visited the project on July 8, 1976 to discuss future collaborative studies in Panama and Colombia. Between August 23-25, 1976 Dr. Belkin consulted with MEP staff members on Anopheles and Culex of the New World. Drs. Gould, de Meillon and Mattingly kindly devoted considerable time towards reviewing major manuscripts.

Dr. Knight in cooperation with Dr. Harbach published 2 more sections of the mosquito glossary, a program initiated by Drs. Knight and Laffoon under the sponsorship of the Southeast Asia Mosquito Project and continued under MEP. The Project has supported the glossary for many years in terms of material and art work and expects to publish the collected parts as a single volume after all have been completed and revised as necessary.

5. Discussion and Recommendations

As planned, the 1976-77 contract year saw the completion of several large monographs on mosquitoes of Southeast Asia and the Oriental region. This has enabled the professional staff to commence devoting its efforts towards a study of one remaining group of Oriental malaria vectors (the Anopheles leucosphyrus group), and several New World groups of vectors (malaria vectors in the genus Anopheles and arbovirus vectors in the subgenus Melanoconion of genus Culex).

The new studies on Neotropical mosquitoes have been greatly assisted by the presence of portions of the John N. Belkin collection which was transferred to the Smithsonian last year. Much significant Neotropical material is now available on loan from the Johns Hopkins School of Public Health through the courtesy of Drs. Lloyd Rozeboom and Milan Trpis. Field studies by 2 staff members, Mr. E. L. Peyton and Dr. Y.-M. Huang in Panama, Colombia and Ecuador have provided several thousand individually reared specimens, with associated larval and pupal skins, for future biosystematic studies on Anopheles and Melanoconion.

In August 1977, it is expected that a military entomologist trained in anopheline biosystematics will be assigned to WRAIR. This person will conduct his research at MEP on Neotropical anophelines of the tarsimaculatus group of the subgenus Anopheles. Thus, research on these malaria vectors should be accelerated with the presence of CPT M. E. Faran.

Although arrangements had been made to send Mr. E. L. Peyton to Belem, Brazil to assist in the training of a field team for the U.S. Army

Medical Research Unit, it was not possible to fulfil these plans in 1976-77. It is recommended that should circumstances permit such arrangements to be made during the 1978 year, that they be carried out in order to assure an ample supply of specimens for future research.

Appendix 1

List of MEP Staff

<u>Name</u>	<u>Date of Service</u>	<u>Organization</u>
*Bryce, George K.	03-28-76	SI
Dery, Ann L. Hoskins	06-01-74	SI
*Flint, Dr. Oliver S., Jr.	07-01-76	SI
Gaffigan, Thomas V.	06-01-74	SI
*Huang, Dr. Yiau-Min	06-01-74	SI
*Linthicum, Kenneth J.	01-26-76	SI
Malikul, Vichai	06-01-74	SI
Paige, Ellen M.	06-01-74	SI
*Peyton, E. L.	06-01-74	SI
Rupp, Janet D.	06-01-74	SI
Schiff, Lotte B.	06-01-74	SI
*Sirivanakarn, Dr. Sunthorn	06-01-74	SI
Smallwood, Penelope B.	06-01-74	SI
Sohn, Young T.	06-01-74	SI
Spangler, Phyllis	06-01-74	SI
Utmar, Joyce A.	06-01-74	SI
*Ward, Dr. Ronald A.	06-01-74	WRAIR

Staff Separated:

Benton, Linda Y.	08-23-76 - 06-04-77	SI
Chang, Suzan Chien C.	06-01-74 - 06-30-77	SI
*Faran, Michael E.	03-28-76 - 04-25-77	SI
Ford, Virginia M.	06-01-74 - 06-18-77	SI
Harrison, Sharon	08-13-76 - 10-06-76	SI
Smith, Thelma F.	06-01-74 - 06-18-77	SI

*Entomologist

Appendix 2

ACCESSIONS OF THE MEDICAL ENTOMOLOGY PROJECT, 1976-77

Source	Number of Accessions	Adults	Slides	Other
Systematic Entomology Laboratory, U.S. Department of Agriculture Washington, D.C.	6	37	0	4 unmounted imm.
U.S. Navy Regional Medical Center, Guam	1	3	0	4 unmounted imm.
SEATO Medical Research Laboratory, Bangkok, Thailand	1	1,248	1,494	0
Department of Biology, University of California, Los Angeles, CA	3	33	39	0
British Museum (Natural History), London, England	7	115	144	0
London School of Hygiene and Tropical Medicine, London, England	2	194	7	50 unmounted imm.
R. M. Rosenberg, Johns Hopkins University, ICMRT, Dacca, Bangladesh	1	1,654	0	1,321 unmted. imm.
University of Maryland, ICMRT, Lahore, Pakistan	3	200	120	0
Johns Hopkins University School of Hygiene and Public Health, Baltimore, MD	3	122	783	30 unmounted imm.
U.S. Army Medical Research Unit (Trans-Amazon) Belem, Brazil	2	654	0	58 unmounted imm.

Source	Number of Accessions	Adults	Slides	Other
U.S. Air Force - Pacific, Clark Air Force Base, Philippines	4	520	0	0
Department of Zoology, Bangalore University, Bangalore, India	1	60	0	100 unmted. imm.
Medisch Wetenschappelijk Inst. Paramaribo, Surinam	2	11	24	11 unmounted imm.
U.S. Naval Medical Research Unit No. 2, Taiwan	1	8	5	3 unmounted imm.
South African Institute for Medical Research, Johannesburg, South Africa	1	149	0	77 unmted. imm.
Los Angeles County Museum of Natural History, CA	1	2	3	0
Bishop Museum, Honolulu, HI	1	13	0	0
National Museum, Colombo, Sri Lanka	1	25	0	0
University of California, Davis, CA	1	922	142	94 unmounted imm.
Rijksmuseum van Nat. Hist. Leiden, Netherlands	2	28	0	0
Museum of Natural History, Smithsonian Institution Washington, D.C.	2	755	0	0
Messrs. A. & P. Bentivoglio, Philadelphia, PA	1	42	0	39 unmounted imm.
Communicable Disease Center, U.S. Public Health Service, Ft. Collins, CO	2	0	100	0

Source	Number of Accessions	Adults	Slides	Other
D.J. Pletsch, Mexico, D.F. Mexico	1	9	0	0
Museum National d'Histoire Naturelle, Paris, France	1	0	7	0
Mosquito Biology Unit, Mombasa, Kenya	1	0	0	4 egg lots *
B.F. Eldridge, WRAIR, Washington, D.C.	1	974	0	0
Notre Dame University, Notre Dame, IN	1	0	0	3 egg lots
E.S. Tikashigh, Caribbean Epidemiological Centre, Trinidad	1	29	0	0
MEP Field Trip, E.L. Peyton Colombia, Panama	1	1,699	0	1,460 unmted. imm.
MEP Field trip, Y.-M. Huang Ecuador	1	2,011	0	2,156 unmted. imm.
Medical Research Institute, Colombo, Sri Lanka	1	27	0	0

21

* 139 specimens reared from the 4 egg lots; 110 with both larval and pupal skins; 29 with pupal skins only.

Summary of Accessions from 1 July 1976 to 30 June 1977

58 accessions (numbers 583-640)

5,407 unmounted immatures
2,868 slides
11,544 adults
19,819 total specimens

Appendix 3

PUBLICATIONS OF THE MEDICAL ENTOMOLOGY PROJECT

- Burger, J. F. 1977. The biosystematics of immature Arizona Tabanidae (Diptera). Trans. Am. Entomol. Soc. 103: 145-258. (April)
- de Meillon, B. 1977. The changing pattern in transmission of Bancroftian filariasis. Proc. 15th Int. Cong. Entomol. 498-504. (March)
- de Meillon, B. and G. van Eeden. 1976. Anopheles (Cellia) deaconi n. sp. from South Africa (Diptera: Culicidae). Mosq. Syst. 8(4): 335-342. (December)
- Ford (Smith), T. L. 1977. Autobiographical vignette. Mosq. Syst. 9(1): 88-90. (March)
- Harbach, R. E. and K. L. Knight. 1977a. A mosquito taxonomic glossary X. The larval mandible. Mosq. Syst. 9(1): 25-57. (March)
- _____. 1977b. A mosquito taxonomic glossary XI. The larval maxilla. Mosq. Syst. 9(2): 128-175. (June)
- Huang, Y. -M. 1977. Medical entomology studies -VII. The subgenus Stegomyia of Aedes in Southeast Asia. II-The edwardsi group of species. III-The w-albus group of species (Diptera: Culicidae). Medical Entomology Studies -VIII. Notes on the taxonomic status of Aedes vittatus (Diptera: Culicidae). Contr. Am. Entomol. Inst. 14(1): 1-132. (March)
- Reinert, J. F. 1976a. A new man-biting species of Aedes (Paraedes) from Southeast Asia (Diptera: Culicidae). Mosq. Syst. 8(3): 319-331. (September)
- _____. 1976b. Medical entomology studies -V. The subgenus Rhinoskusea of the genus Aedes (Diptera: Culicidae). Contr. Am. Entomol. Inst. 13(2): 1-60. (November)
- Sirivanakarn, S. 1976. Medical entomology studies -III. A revision of the subgenus Culex in the Oriental region (Diptera: Culicidae). Contr. Am. Entomol. Inst. 12(2): 1-272. (July)
- _____. 1977a. Additional descriptions of three species of Culex (Eumelanomyia) with the description of a new species from Peninsular Malaysia (Diptera: Culicidae). Mosq. Syst. 9(1): 73-87. (March)

- Sirivanakarn, S. 1977b. Redescription of four Oriental species of Culex (Culiciomyia) and the description of a new species from Thailand (Diptera: Culicidae). Mosq. Syst. 9(2): 93-111. (June)
- Ward, R.A. 1977a. Recent changes in the epidemiology of malaria relating to human ecology. Proc. 15th Int. Cong. Entomol. 523-529. (March)
- _____. 1977b. Culicidae, pp. 268-274, in "Biota acuática de Sudamérica austral", S.H. Hurlbert, ed., San Diego State Univ. (May)

Appendix 4

MEDICAL ENTOMOLOGY PROJECT CONSULTANTS

- Dr. John N. Belkin, University of California, Los Angeles,
California - New World Culicidae.
- Dr. Pedro Galindo, Gorgas Memorial Laboratory, P.O. Box 2016,
Balboa Heights, Canal Zone - New World Culicidae.
- MAJ Bruce A. Harrison, North Carolina State University, Raleigh,
North Carolina - Oriental Anopheles.
- Dr. James B. Hitchcock, Jr., Malaria and Parasitic Diseases, World
Health Organization, Geneva, Switzerland - Pacific
Culicidae.
- Dr. Botha de Meillon, Philadelphia, Pennsylvania - Culicidae of
Africa and Southeast Asia.
- Dr. J.M. Klein, Institut Pasteur de l'Iran, Teheran, Iran -
Oriental Culicidae.
- Professor Kenneth L. Knight, North Carolina State University, Raleigh,
North Carolina - Aedes (Finlaya) and mosquito glossary.
- Dr. Peter F. Mattingly, British Museum (Natural History), London
England - African Culicidae and Tripteroides.
- Dr. J. Rageau, ORSTOM, Bondy, France - Culicidae.
- Dr. Shivaji Ramalingam, University of Malaya, Kuala Lumpur,
Malaysia - Topomyia, Malaya, Armigeres and Malaysian
Culicidae.
- Dr. Graham B. White, British Museum (Natural History), London
England - African Culicidae.

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